EV Fast Charging
Technology and Standards at UD

"Fueling the Future" (DNREC)

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UD R&D on EVs

- Markets, users, technology & policy on EVs and grid
- Design charging networks that are better targeted to actual EV driver needs
- Design high-power, low-cost charging stations
- Create the **Grid Integrated Vehicle** (GIV), then operate, permit, and test
- Technology transfer: Form alliances and/or license technology to each sector -- power, automotive, electric manufacturing etc.

Using EVs for longer trips

- Either
  - Larger Battery, or
  - Faster charging
- The faster charging option is MUCH less expensive, if done correctly
- UD has developed low-cost high power charging stations

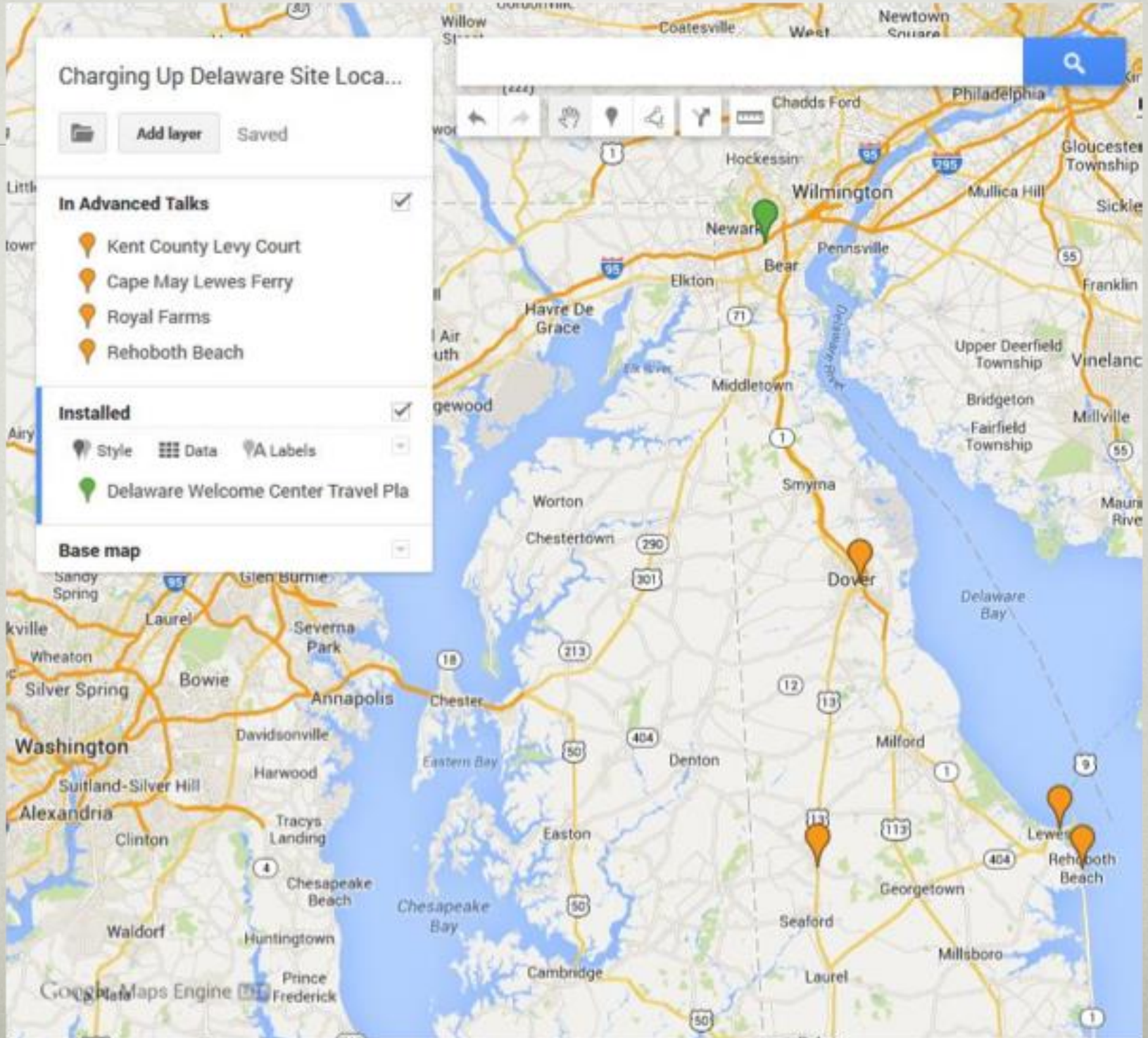
Alternative approaches to fast charging

- US/Japan J1772, “Type 1” single phase, 240 or 208 volts --> 16 to 19 kW , or
- International, IEC “Type 2” three phase, 480 volts, 100 amp -- 83 kW
- DC charging, three standards (CHAdeMO, Tesla, CCS) charging speed (50 - 120 kW)

Charging Location and Placement can be haphazard

- Existing: Low-power, not en-route
- Seek “willing locations” rather than design for en-route fast recharge
- Diversity of payment schemes mean high cost and high barriers to use
- UD project with DNREC: Small number of public en-route charging stations, Type 1 (19 kW), placed strategically

Charging-Up Delaware: Site Locations Map
July 23, 2014



I-95 Welcome Center

- Allows for in-route charging
  - Travel to Dover (and therefore beaches)
  - Travel to Maryland (and therefore Baltimore and D.C)
- Designed Signs for Site
- Have seen Great Usage since installation (July 2014)

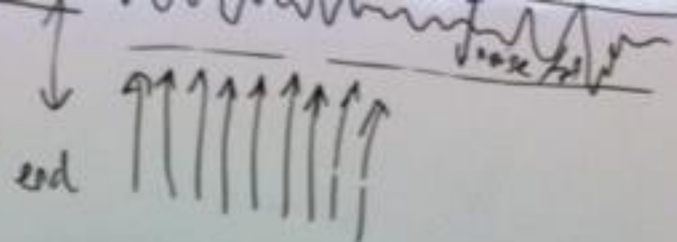
Pictures taken from user postings on PlugShare

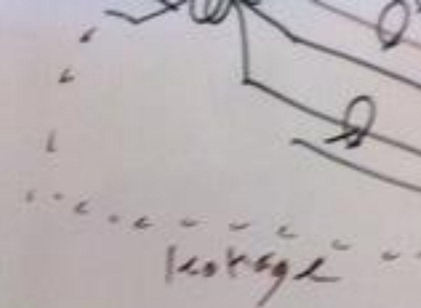
Surfside Park-Rehoboth Beach

- Serves as destination charging
- Allows for EV drivers in Delaware be able to take day-trips to Rehoboth
- Installation occurred in June 2015

Next Project

- Design high-power, low-cost charging station (use IEC Type 2 standard: Three Phase, 208 to 480 Volts)
- Develop a US standard for this charging station: SAE J3068
- Design and build conforming stations



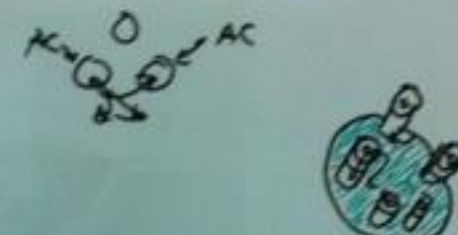


methods for managing & protecting evs

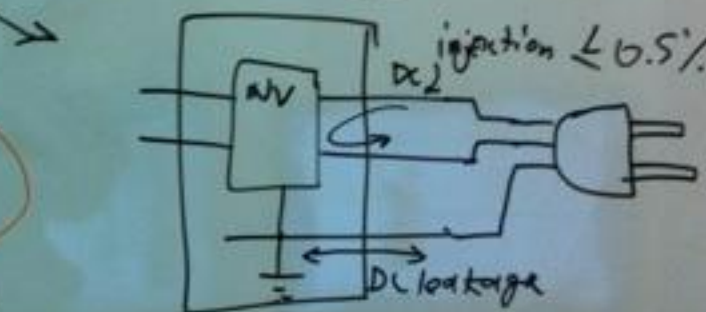
NEW IDEAS

- shielded plug
- DC injection + leakage RCD
- J1772 - protective RCD
- Continuous on-line RCD test
- power managment intreated
- J1772 supervisory safety in RCD
- on-line monitoring of variables of interest
  + adjustable trip conditions
  + remote reset

profiling for value



$240 \times \frac{1k}{100k} \Rightarrow$



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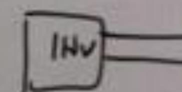
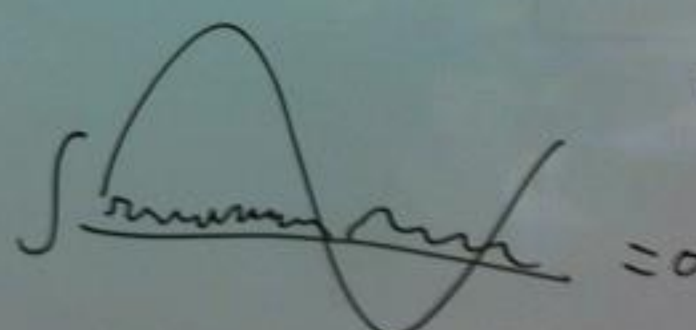
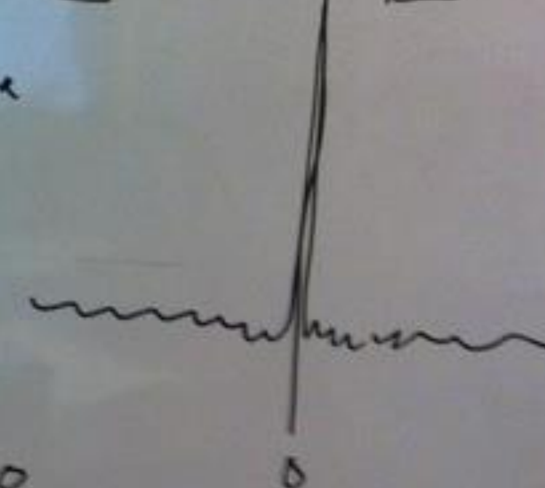
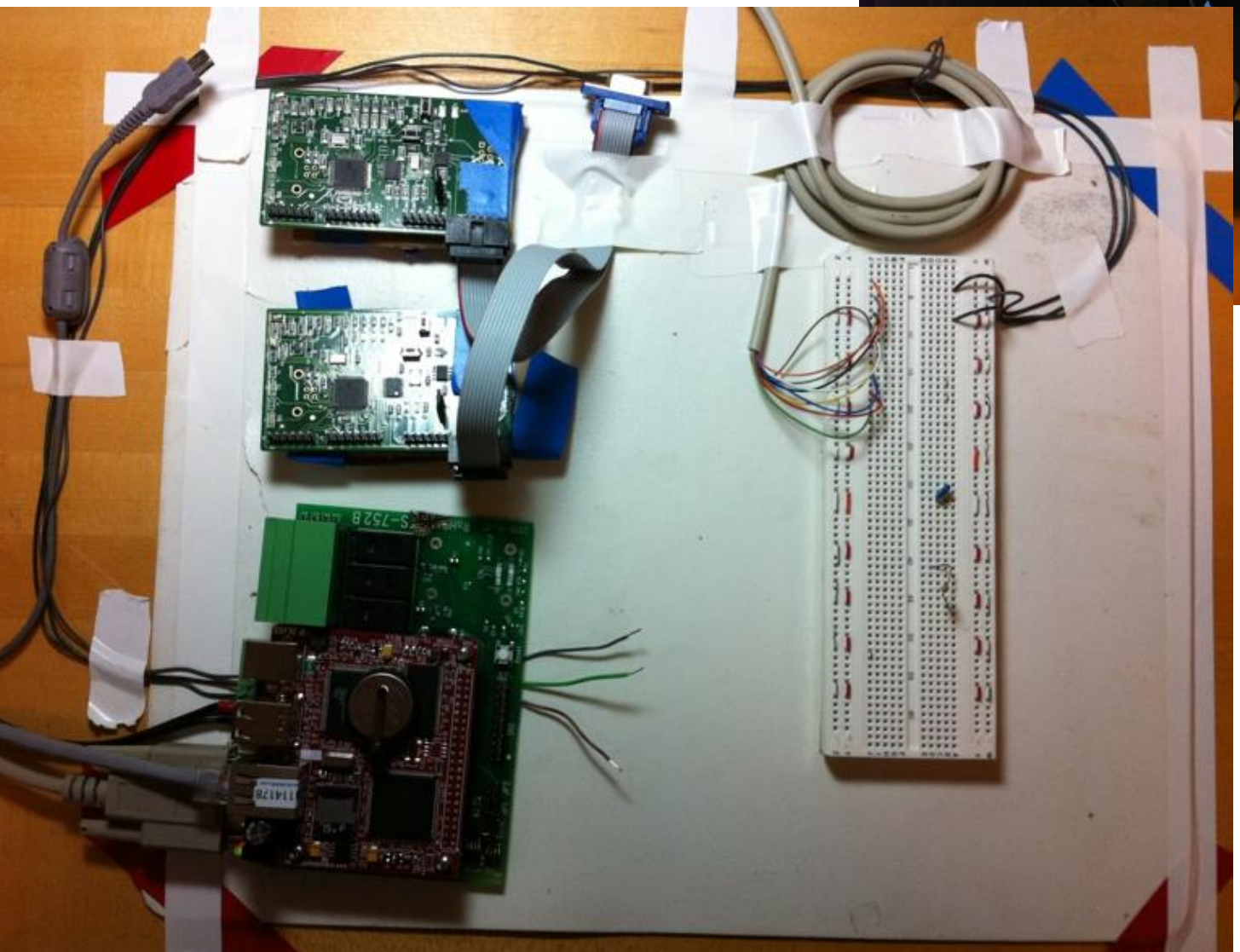
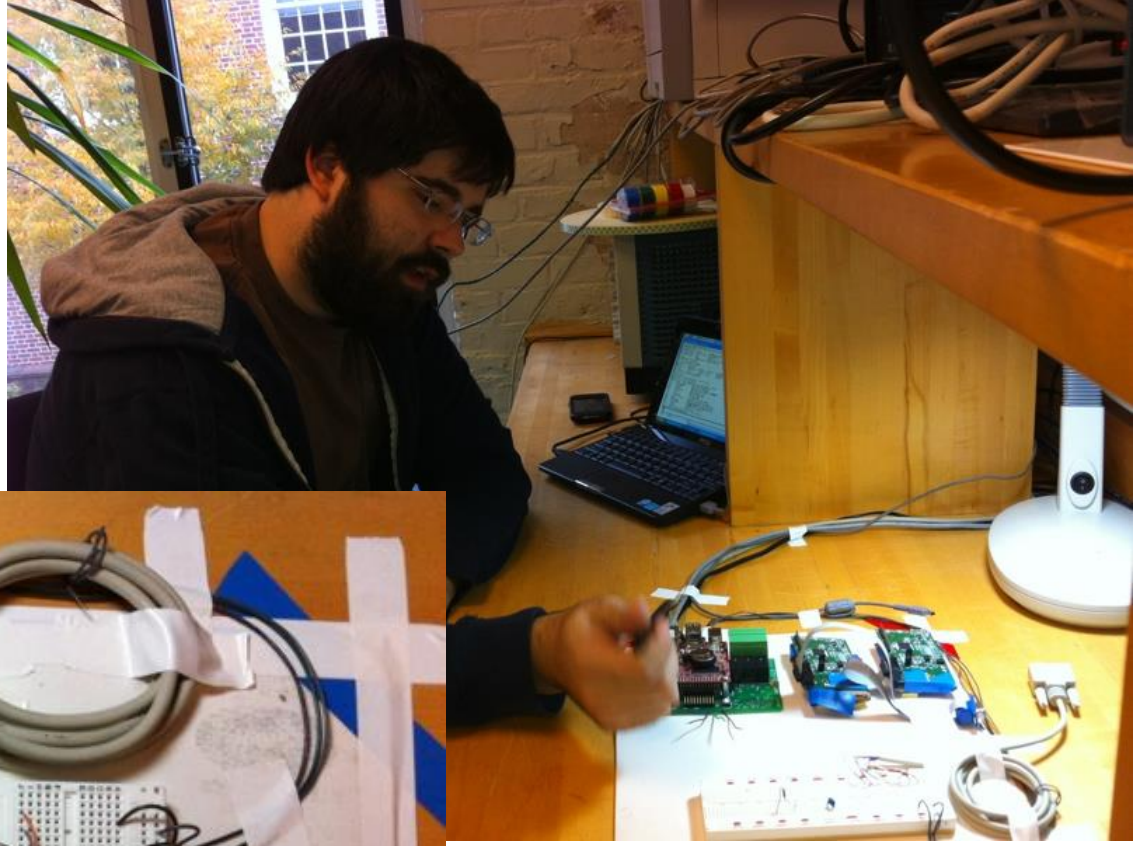






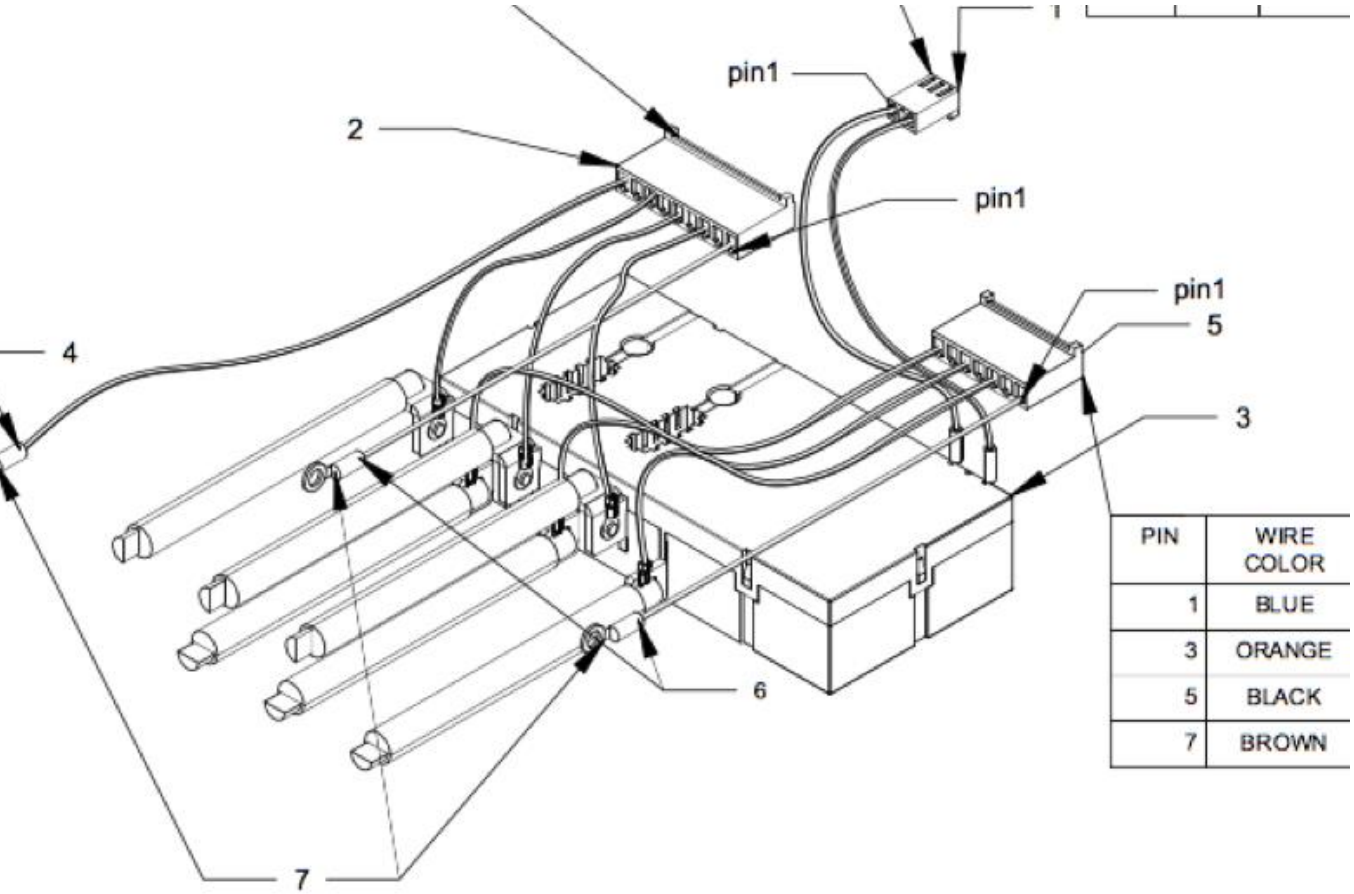
Breadboarding



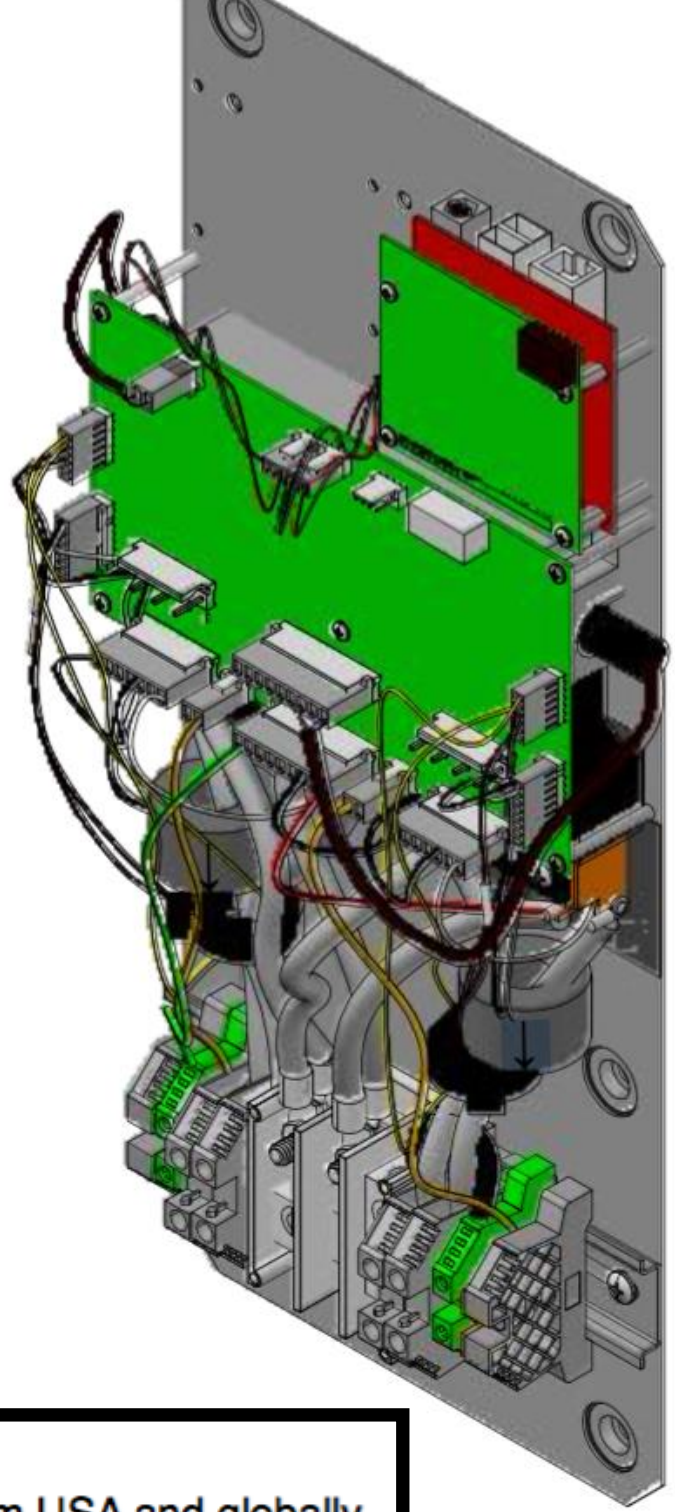


Extensive testing

Drawings for manufacturing

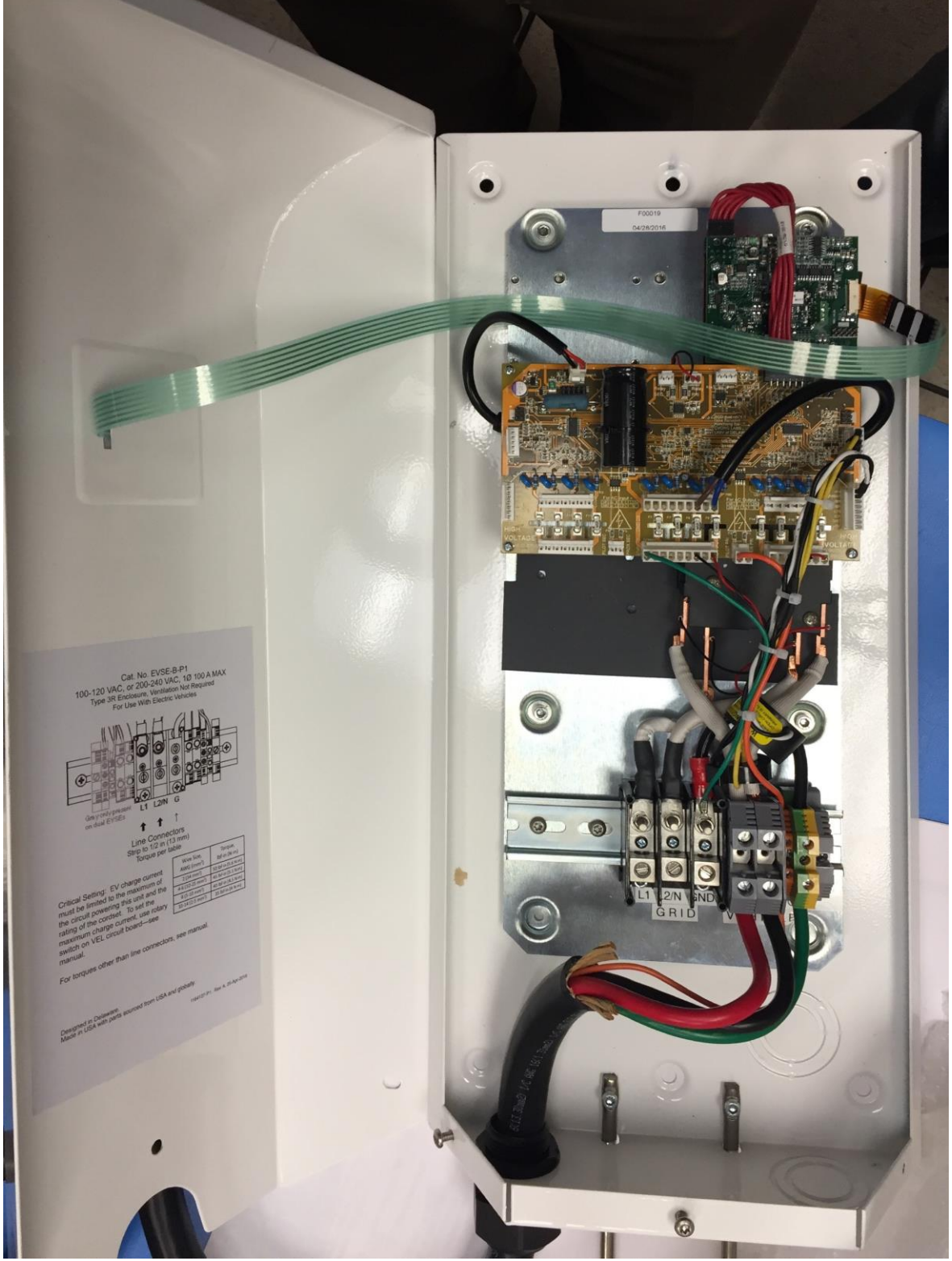


PIN	WIRE COLOR
1	BLUE
3	ORANGE
5	BLACK
7	BROWN



Designed in Delaware.
Made in USA with parts sourced from USA and globally.

Manufactured EVSE



Cost for AC Charging

- Single-Phase, 19 kW, retail $1750
- Three-phase, 83 kW, retail $1990
- Currently three-phase EV sedans are sold in Europe, not yet US, many same models: BMW i3, Tesla, Renault, etc
- US market starting with trucks and school buses, cars later

Type 2, three-phase charging

Tested to charging standards at National Renewable Energy Lab, Golden, CO

Expecting 3-phase retrofit for a sedan, near-term

Conclusion

- Strategic location of chargers enable trips statewide.
- Fast charging need not mean expensive charging stations
- UD working on new designs, promoting industry standards, and technology transfer
- And, yes, at UD we also invented V2G.

END

More information:

www.udel.edu/V2G

http://www.udel.edu/V2G/